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*REVIEW ARTICLE*

# COMPUTER-AIDED DESIGN and VIRTUAL REALITY in ARCHITECTURE

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## ABSTRACT

The constant development of technology has resulted in virtual reality being included in almost every aspect of our lives. Today, the opportunities offered by technology have made many conventional methods redundant, which is especially the case in the field of architecture. The sophistication of software and hardware customised for architecture means that computer literacy and keeping a close eye on technological progress has become a prerequisite for actors in the profession. The undeniable role of computer skills in professional development also presents itself in academic environments. Virtual reality is now integrated into all areas of education while the share of computer-aided design in architecture is growing steadily. These developments bring on the need to introduce different perspectives in architectural education. Computers have made it possible for students to transform abstract thoughts in their designs into concrete data much more quickly and easily with the assistance of custom hardware and software. This study aims to bring a different perspective to architectural education by explaining how virtual reality can be employed in computer-aided designs in architectural education and the new potentials it offers. In this context, the situations created by the processes before and after the use of technology in architecture were examined in detail. As a result of the examinations, it is understood that it is necessary to follow and use the developing technology in architecture, but it should also be used in the traditional method.

**Keywords:** *Virtual Reality, Architecture, Architectural Education, Design, Computer*

## 1. INTRODUCTION

A retrospective examination confirms the continuous change and evolution of technology. The introduction of machines in our lives, especially in the post- industrial revolution period, has led to great changes in the field of architecture. During this process, in which the use of computers increased exponentially, architectural designs have rapidly migrated to digital platforms while many basic components such as the design process have gone through significant changes.

Information technologies have been used for the purpose of architectural education for more than 20 years. The use of digital design methods is on the rise around the world and in Turkey. Information technologies have been adopted by architecture schools in Turkey parallel to the rest of the world. The use of such technology has accelerated as greater numbers of academicians and architecture students

have got accustomed to using computers [1]. The development of architectural design software has also meant that these applications now have an important place in the field of education. Learning these programs during education also give students an advantage in their professional lives [2].

Currently, a combination of conventional methods and digital technologies is used in architectural education. Conventional methods in architectural education, which rely on paper, pencil and models, are still used extensively. Digital technologies are used as complimentary instruments to the former. However, this can be considered as a transition phase to digital technologies [3]. Architectural education programmes start with the conventional method and then move on to two-dimensional drawing with digital software before progressing to visualisations with three-dimensional models. Computers should be considered as a tool that provides architecture students the opportunity to experience different aspects of their designs. While conventional methods allow architecture students to get hands-on experience with tangible objects, computer programmes make it easier to access processes and resources related to design [2-4].

Computer technologies in architectural education originally started with two-dimensional drawings using CAD applications. Today, it is used for basic designs in applied projects. However, with the introduction of three-dimensional modelling techniques around the mid-1980s, the focus shifted towards visual expression [2-5]. Computer software helps designers evaluate spatial relations and develop their designs [6].

Visual communication improves dialogue between professionals and the general public, increases understanding and improves decisions, which explains why it has become an increasingly common practice in environmental decision making [7]. We perceive the world three-dimensionally, so there is a growing need for three-dimensional images generated by computers or similar implements [8].

In the face of technological progress, the development of societies relies on keeping up with changes and adopting new technology into their lives. To do so, modern societies carry out studies on the use and development of new techniques and methods in the field of academic teaching and learning. Known methods and techniques in education gradually become inadequate and even invalid as technology develops. As one of the many innovations introduced with new technology, virtual reality has brought a new perspective to education and training methods [9]. "It is claimed that the virtual educational environment model is an important tool for architectural education to adapt to current technological developments and ideational changes" [10].

The introduction of computer technologies in the field of architecture has also brought a new perspective to design. Computers have made it possible to realise design forms that would be considered difficult or uncalculatable with conventional methods. Architectural design has also evolved with the technology-based development of previously limited materials and construction methods. Collectively, these changes and developments have led to the emergence of a new design concept.

Considering the very broad topics of technology and virtual reality, this study has been limited to the investigation of computer-aided design processes in architecture and the introduction of virtual reality in architectural designs. The aim of the study is to identify the contributions of computer-aided design to architectural education.

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## 2. MATERIAL and METHOD

Conventional methods are quickly being replaced by computer technologies in architectural education. It is very likely that conventional methods will be abandoned completely in the near future. This study will first provide a brief overview of the evolution of architectural design education; second, evaluate changing phenomena and concepts in design following the introduction of computer-aided designs; and third make predictions on the future of architectural design. Subsequently, the existing academic system will be evaluated in conjunction with vocational experience before making forecasts about the nature of the education system in the future.

In order to make it easier to understand the place of virtual reality in computer-aided design in architectural education, the method of the study has focused on addressing the historical evolution from the origins of architectural design, especially the point where the concept of computer-aided design became adopted into the design process in the form of a literature review based on publications, theses and articles. In this context, changes in architectural designs were examined before, when and after computer technologies were included in this process. The positive and negative effects of each new method introduced to design education in architecture have been examined and evaluated periodically in terms of students, academicians, architects and customers. The data and experiences acquired during this research have been presented in the conclusion in order to shed light on future architectural education and training.

## 3. THE HISTORIC DEVELOPMENT ARCHITECTURAL EDUCATION and DESIGN

Architecture is structurally complex, contradictory and intertwined with abstract concepts. Architecture involves tangible elements such as material, structure, building; quantifiable elements such as mechanics, static and topography; as well as unpredictable factors such as nature, experience, existence, and human beings. According to Cook (1996), these quantifiable and unquantifiable factors are both the most enjoyable and most daunting aspect of architecture [11]. The numerous, constantly evolving variables of architecture have forced changes in architectural design education. Design education is based on lectures and conventional teaching. It also aims to build on student creativity and provide the knowledge which allows non-verbal expression as the source of actions based on capabilities [12-13]. Design studios and basic design courses complement students' aesthetic and artistic talents by building on their sensory, perceptual, critical, mental and visual aspects. Certain courses such as concepts, theory, and design knowledge aim to improve the design theory foundations of students. Courses like technical drawing, structural knowledge, and narrative techniques, support the expressive style and technical design knowledge [13].

Architecture requires making designs that consider predictions about the future. Thus, approaches to design must be based on an inquisitive perspective rather than stereotyping. The most important transformation in architectural education is introducing architecture students a perspective that embraces change. The architectural education system must be open to new methods [11]. Unquestioned knowledge hinders imagination. This is why, conventional rote education must be avoided at schools. There is a need to provide environments that give students hands-on experience; a setting where they can question freely, learn from practice and even from mistakes [14]. Unlike many other degrees, architectural education is based on learning by practice and gaining experience [13-15]. The studio tradition in architectural education provides students with the main design experience and can be regarded as the core of the education programme. Architecture must keep a close eye on the

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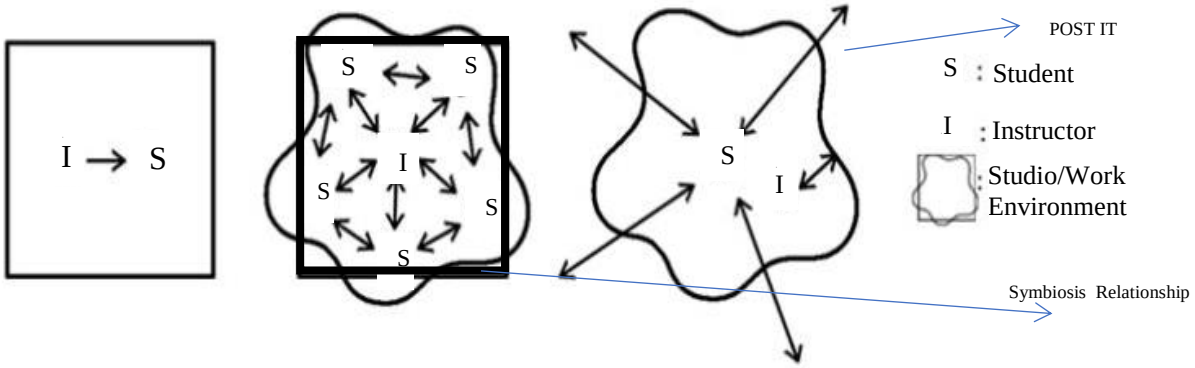
changes and developments of the time. Architectural education and design studio curricula must keep up with the changes taking place in the world. Design studios have constantly evolved from the past to the present and will continue to do so. Historically, architecture education and studios can be examined in three periods [13-16]. In the first period there was no structured architectural education, design education or studios. During this period, knowledge was transferred in context of a master-apprentice relation. An apprentice would learn architecture by observing and helping his master at work [17]. The unconditional superiority of the master was emphasised [13]. The master-apprentice relation continued into the second period of architectural education however, the theoretical aspect of education was provided in a school setting while the applied side took place in offices [17]. The beginning of the second period corresponds to the establishment of the French School, the first independent architectural school, which was followed by a turning point which saw the discipline of architecture breaking away from the traditional architectural education practice. The second period triggered a new era in architectural education. In the third period the Ecole des Beaux-Arts education system was adopted which led to the integration of practical work in the academic curriculum and the studio concept being an integral part of architectural education. This is also when the first studio system was implemented [15-18]. During this period, students also experienced an intensive design process, investigating problems with their peers and instructors [19]. Bauhaus brought another perspective in this period. In contrast to the Beaux-Arts model, the Bauhaus system focused on freeing students from conditionings, allowing them to expresses creativity and imagination individually [18]. Although the Beaux-Arts model had existed in architectural education for a long time, its prominence was weakened with the emergence of the modernist movement. Architectural education was influenced by Bauhaus throughout the first half of the 20$^{th}$ century and the number of design schools increased [13]. In the master-apprenticeship method, the master simultaneously transferred all his theoretical design and application knowledge to the apprentice. However, this system became




inadequate as demand for architectural solutions increased. Academies started to provide theoretical education. The applied part of the education continued in architecture offices outside the school [17].

As shown in Figure 1, considering the evolution of the approach to architectural education and its modern version practiced today, design in architectural education can be examined in three different ways. The first is the approach dominated by the master-apprentice relation. This approach is instructor-centred and information transfer is one-way, from instructor to student. This method does not allow students to ask questions and the instructor's knowledge is undisputed. The environment, the problem and the finished product are completely physical in this approach. The second approach is the empathic student-teacher relation. There are more students and the transfer of information is two-ways. This method practiced in design studios. The studio and problem are physical. The student

develops the design problem in the studio and works with the contributions of fellow students and instructors. During this process students learn design education. The student has more say in this method compared to the master-apprentice relation. The third is the post-IT approach. In this method, the architecture studio puts the student in the centre. Students can interact with peers in another studio through electronic communication. The virtual network provided by computer technology makes it possible for students to collaborate with users from all over the world. In addition to physical problems, hybrid and virtual problems are in the forefront and emerge as the subject of the architectural design studio. The virtual environment has also altered the limitations on accessing information. In this context, schools should follow developments and constantly revise curricula in order to keep up-to-date and provide a sound education [17]. In an age where designs concepts are changing constantly, it is extremely important to effectively benefit from new media and technologies to ensure the continuation of a design discipline [20].

## 4. COMPUTER AIDED DESIGN and VIRTUAL REALITY in ARCHITECTURE

The first computer drawing was made in the 1960's. This was also when designers were introduced to computer technologies. The hardware and software made available by technological progress has meant that computers have become important auxiliary tools in architecture. Computers are mostly used to present the stages of architecture and interior architecture. Such presentations often use a large number of computer-generated perspective images and animations based on the designs. The use of hand-drawn perspective sketches is now mostly limited to traditional presentations. Today, images from different angles of the modelled image are used in the presentations [21].

Today, technology makes it possible to reflect everything that can be physically perceived in a different medium. Real environments can be created with three-dimensional imaging and simulation techniques [21]. As shown in Figure 2, the virtual space designed with computer-aided design systems is first drawn in two dimensions before a three-dimensional model is created. It is a process that requires simultaneously considering two and three dimensions. In some software, the space is initially drawn in two dimensions after which it progresses to three dimensions. Some software creates two and three dimensions simultaneously.

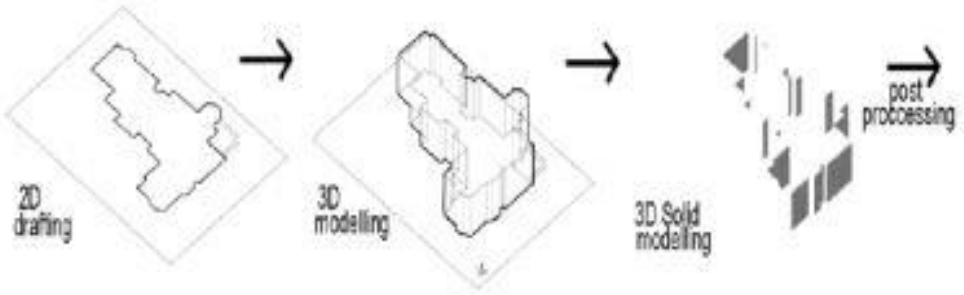
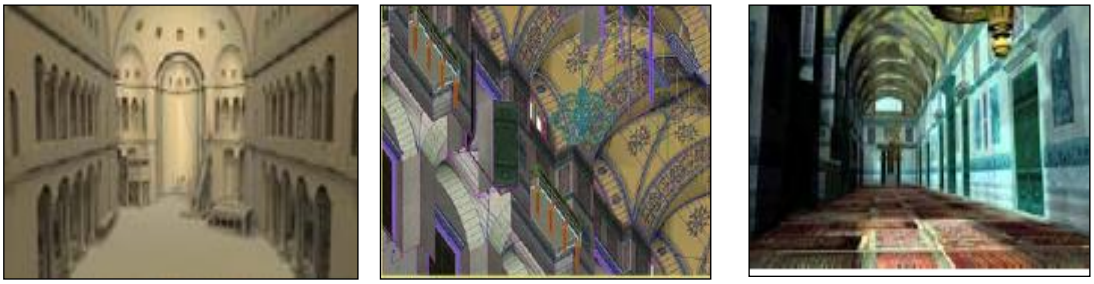



**Figure 2.** Visualisation of architectural design in CAD software [22].

As shown in Figure 3, models based on computer-aided designs can deliver the appearance of a real image with the help of other software. Material and lighting are assigned to the model in the last stage. These settings are the most important details that make the model give the impression of a real image.

Life-like images can be created by superimposing the model with a particular environment using template objects or created objects.



(a)modelling (b) material (c) lighting

**Figure 3.** Visualisation of the Ayasofya Model [23].

Virtual environments created with three-dimensional models can be used for virtual reality simulations. This allows the user to move freely inside the model. Stimulating our audio-visual senses, it is possible to create spaces that can be experienced and interacted. Virtual spaces can become spaces that can be experienced with multiple senses [23]. Users can move around within the simulated models. The nature of mutual interaction comforts the users [21].

**Figure 4.** A Virtual Reality Museum [23].

Architecture is the visual realisation of human imagination. These ideas are functionally made real with computer technology. Following the emergence of the "immateriality" concept, the foundation has been laid for merging the relation between the physical material dependence of architecture and computer technologies. Immateriality is replacing the physical material required for architecture with images and interactions provided by computer technology [24].

According to Anders (1999) all architectural projects in the future will be designed virtually. Cybrid is the physical and cyberspace community. Cybrid can involve virtual additions to real buildings or real spaces incorporated in cyberspace [25]. It appears that the future will be about cybrid (hybrid) designs using a combination of immateriality, physical space and virtual spaces [21].

"Virtual Reality can be defined as computer-generated 3D simulations in which users can physically interact with virtual environments and objects by means of custom electronic equipment such as headsets equipped with screens and various sensors, gloves and remote controllers. The most important feature of these simulations is that it creates real feeling of being there. This is made possible by interaction with immersive images that stimulate audio-visual senses, as well as giving users the ability to interact with virtual formations using various physical movements" [10].

According to Franck (2002), the concept of virtuality is not the opposite of reality, it is rather one of the layers of reality. Franck argued that the concept of virtual is real and refers to the intangible. Franck claimed that virtuality is "the ability of revealing the essence of something that actually exists inherently - that is, without transforming it into an object" [26]. The author noted that virtual architecture is "real and potential architecture and finds application in the digital world's laboratory and sheltered living spaces. Architects are also cyber architects" [26-27]. Önder believes that designers of virtual spaces do not have artificial intelligence, and that they may be dreams based on people's experiences. This is why the author thinks that images of the physical world will find a place in a virtual space setup [28]. Önder states that virtual spaces actually create images of the real world. In virtual architecture, real events, time and space are presented with the help of digital technologies, whereas traditional architecture relies more on fixed forms and precise geometries [17].

Virtual education applications of universities in the fields of architecture are very diverse. Özlem Ünkap (2006) examined virtual reality applications applied with different methods in architectural design studios. Studio studies have been made in cyberspace where the object is a physical or physical concept. In his other study, studies in which the entire environment of the design is cyberspace and the object is virtual were examined. In another study, workshops using cyberspace as a tool were examined. As a result of all these studies, it has been observed that a person can participate in the design and application method in different disciplines. It has been observed that the design process feeds on itself and new creative opportunities are provided to the designer. The application area of virtual architecture is cyberspace. Cyberspace is a universe consisting of communication networks and computers and supported, in which global information is transformed into form [17].

Virtual reality technology allows architecture students to observe every stage of space design from a critical and different perspective. Proficiency in using virtual reality and effective time management are important. This technology might also improve student motivation for design. Students can create a social atmosphere and also bring different and new approaches to designs. Since virtual reality can be remotely accessed, physical locations are irrelevant. This technology has become extremely important for students to be able to acquire a more realistic perspective to their designs [29]. In a sense, virtual reality technology has made it easier to perceive. Thus, the solution to previously complex concepts has become easier. In this context, architecture students develop on their design motivation and creativity. In the course follow-up, students who were independent of place and time were seen to gain flexibility in design [21]. It would be positive to include virtual reality in architectural design environments as it develops 3D thinking, allows existence in the design process, and provides different perspectives [20].

## 5. APPROACHES to DESIGN EDUCATION in CONTEMPORARY ARCHITECTURE

A finely designed product is no longer adequate in the current approach to architectural design. It is important to create a behaviour on how design can be done. In this context, questions such as "What is design education? How is it given and how should it be given?" are becoming increasingly important in design schools [18]. In this evolving process, the question of "How can we teach better?" has changed to "How do people learn" [13]. Regarding the design process, it is of great importance in terms of architectural design education that the student tries and fails the design during education and is actively involved in all stages of the process.

The biggest problem of students starting architectural education is to interpret and visualise the spatial relations of the products they create with the abstract sketches of their imagination. Students initially visualise these abstract sketches with tangible tools such as pencil, paper and model [30]. In architecture, all products designed from the equipment inside the building to the structural and urban scales should be defined with technical expressions and according to architectural standards. These expressive techniques are two-dimensional drawings. The technique of expressing design idea by drawing is regarded as the main method of visualisation since the Renaissance [31]. The perspective and models created facilitate the presentation and perception. This is why, it will be more effective to use conventional methods in the early stages of an architecture student's development when they lack concepts and cannot establish a relation with objects. It is thought that this will help create better design awareness.

In the traditional method, the student is seen to have a passive role limited to receiving information; an empty object that needs to be loaded with information. During some aspects of architectural education, students can become more involved, especially in applied courses and field studies. Occasions that activate the student can be diversified with hyper-media tools. Considering technological developments and the requirements of the age, hyper-media must take a leading role in abandoning passive practices that merely load students with information. Most of the problems related to architectural education can be solved with the help of computer technologies [14]. However, while it is necessary to expose students to these technological processes, it is equally important to rely on the conventional method in which abstract ideas are rendered tangible with touch and feel in the initial stages of design in architectural education.

Computers were first used to carry out analytical calculations in engineering designs. "Computer-aided design (CAD) began with the development of the SKETCHPAD system in 1962-1963 by Ivan E. Sutherland in the laboratory of the Massachusetts Institute of Technology (MIT)." With the help of light and pencil (ligh-pen), designers using SKETCHPAD were able to design directly on a screen for the first time. The system developed by T. E. Johnson in 1963 made three-dimensional modelling possible [32-21]. The CNC (Computerized Numerical Control) system was introduced in the late 1960s to use in the production of designed objects [33]. Due to economic constraints, computer-aided design was not used widely in architecture until the 1970s. In 1970, only 50 companies in the world were using CNC machines in the design and production of complex surfaces [33-34]. AUTOCAD 1.0 was launched in 1980, and software witnessed a rapid development, making it possible to make most of the drawings of conventional architecture. AUTOCAD R9 and Autoshade 1.0, allowing CAD versions, curved 3D visualisation, wiremesh technique, and shading, were released in 1987. The unbelievable software development between 1990 and 2000 was made computer modelling possible to common users. The first version of 3d studio max was released in 1990 and its use became widespread

in a short time. In 1991, the Adobe Photoshop suite was released bringing success in computers-aided visualisations. 1992 saw the release of the Form-Z programme which has been crucial in creating free curves in modelling [35]. Collectively, these developments demonstrate that there has been a shift in the concept of design which now relies significantly on computers. Computers became widespread in architectural offices in 2000 and CAD software was used for different stages of design. With the development of computer-aided design, computers are now used as the primary drawing tool in architectural design. Computers also serve different functions such as presentation, communication, quantification, simulation and engineering calculations [21].

With the help of computers, architectural design has abandoned the traditional paper, pen and model and embraced a new, digital medium. The digital age has shortened the time needed for the design processes and made it possible to collaborate and work simultaneously. The internet provides a global working environment and the opportunity to gather on a common ground. Creating a digital space that does not exist physically has enabled the building or object to be formed and experienced in three-dimensional space [36].

Studies carried out by Işık have revealed the importance of using architectural drawing software in architectural education. Students are aware effective use of architectural drawing programs will also be an advantage in their professional lives. However, although design software abilities are important in professional life and architectural education, students need to make hand-drawn sketches and improve their skills. In this context, it seems more appropriate for four-year undergraduate degrees in Turkey to start education with conventional methods [2].

## 6. DISCUSSION

It is important to evaluate the dimensions of a place in architectural designs, as is to select the assessment approach for design technique. Each architect employs different techniques in developing designs. However, the development and dissemination of computer-aided design techniques also offers new opportunities. Modelling the space in three dimensions considering space limitations and experiencing virtual tours quickens the decision-making process during the construction phase of the building. Virtual reality has been criticised by many circles based on concerns that VR disconnects humans from reality, that the experience is socially insufficient, and that architects are losing a battle against technologies. These expectations have not materialised yet. On the contrary, it is important to understand that computer technology has enabled architecture to establish new relations with different disciplines. In modern architecture, interdisciplinary interaction is inevitable in creating an environment that is in harmony with social, economic and technological forces [37].

The fact that current computer-aided architectural modelling and presentation techniques create realistic images has led to a perception that architecture is a virtual image. This technology is now used extensively by investment and real estate companies as a major marketing tool. For this reason, the current market expectations are more in favour of quickly completing a design that is visually appealing. Today's market has made the use of computer technology compulsory. Computer technology has emerged as a design method rather than being an auxiliary tool in the design process.

Providing visually stimulating three-dimensional objects in two-dimensional planes have largely removed tactile stimulation from the process. Pallasmaa expresses his concerns about computer technologies: Computers are often seen as a useful invention, as they liberate human thought and offer

efficient design possibilities. Computers create distance between the designer and the object. Whereas Designers have a tactile contact when they draw and model by hand. The imagined design is physically modeled. You can be inside and outside the object at the same time. Creative design is formed by physical and mental identification and empathy. Computers turn this design process into a visual manipulation [38-39].

As one of the leading theoreticians and important architects of our time, Steven Holl, creates his designs by drawing numerous sketches in the design process, and relies on the model-making technique for three-dimensional expression. Holl experiences the tactile properties of the materials that make up his designs, the use of light as a material, and the relation between design and place. The architect turns to computer technology in the final stage of the design. Conventional methods play an important role in Holl's design process [39].

As technology made a stronger presence in the field of architecture, digital programmes and software gained significance in architectural education mainly due to market conditions and the ease of tackling labour-intensive, difficult projects. In this respect, architectural education must be open to progressive design programmes and students should be informed about such developments [2].

Schoon (1992) and Moloney (2001) reported that creative architectural design solutions often come from students who repeatedly work on their sketches and who critically examine designs. Computers provide easy access to sketches stored on the system as well as a wide range of solutions which expands student interest in architectural drawing programs. It appears that the three-dimensional thinking abilities and model-making skills of students have increased with the growing use of three-dimensional drawing programmes [2]. However, the current tendency is to introduce computer aided design training after the student has acquired a theoretical foundation in architecture and gained a certain degree of experience in conventional architectural design methods.

Sketching is very important in the architectural design process. However, the computer is a very powerful tool, which is very effective in modeling sketches, making models, making fine calculations, realizing details, starting production and most importantly, expressing designs. In today's conditions, it becomes impossible to stay away from computer technology, which enables the design and implementation process to work together in a very short time, with minimum error and maximum efficiency [40]. With the development of computers as well as technology, architecture has begun to exist even before it is built [41]. . Leach stated that the success in architectural designs affects the dominance of the tools used. Thus, he stated that computers are the most powerful tool in designs [42]. In terms of design contribution, parametric designs using computers can be one of the most successful design methods. Parametric design is a computer aided (CAD) design method using parameters. In architectural designs where parametric design is used, environmental data such as density in human flow, wind intensity, and sea salinity can be defined as parameters used in the design process. These data cause the form, detail and structure of the design to change. Changing one parameter affects all parameters. Thus, designers will be able to easily identify the source of the problems, their relationship and interaction with other elements [43]. Although parametric designs are mostly used to create forms, they provide great convenience in giving the details of the building units during the application phase of the form. Thus, interdisciplinary work will be facilitated and the construction process will be carried out with minimum error and important details [44]. It would be very wrong to prepare architecture students for the profession with only traditional methods in a time when designs are rapidly made with these methods.

Today, there is a clear shift from conventional design studios towards digital and open source design studios that rely on two- and three-dimensional expression techniques, electronic libraries, online video supported collaborations, and web archives. It is very likely that information technologies will contribute to a global common virtual design studio and joint project teams in an environment of intercultural interaction [17].

Considering the information provided, challengers of architectural education agree that architectural education should not be limited to studios and schools. The real world is a place of observation for architecture students that becomes a part of the environment in education [11].

## 7. CONCLISIONS

Research results suggest that computer technologies contribute significantly to the fields of architecture and interior architecture. Architecture does not rely on verbal expression, so it is crucial to present the created product before the application. In this context, many design problems can be solved efficiently with computer technologies. Computers make it possible to quickly and cheaply prepare presentations. It is easy to capture images and details from the relevant parts of the designs. Once created, these objects can be used in other designs, too. Users can virtually wander around the model for a full experience of the design. Computer-aided modelling is much easier than physical model-making. In addition, current computer technology creates very realistic images that feature different material options and lighting configurations to provide the user a realistic impression of the end result.

Advanced computer technology has found applications in various sectors. Students gaining professional experience in these sectors have also introduced technological developments to architectural education. In an age where time and efficiency are priorities, it is necessary to migrate from conventional methods to computer technology. Hand-drawing plans, sections, views and perspectives, calculations followed by model-making previously took days to complete using conventional methods but computers allow the simultaneous progress of all these aspects. A change made on a computer design will modify and/or correct all related drawings and plans, a problem that would require complete re-drawing in the conventional method as well as delays and additional costs.

Modern technology also makes it possible to use a combination of conventional methods and computer technology. Designers can also integrate different handmade components of the design with computers. At the same time, traditional methods can be used on computers. The best example is graphic tablets. Digital drawings can be made with the special pen that come with the tablets; stored on the system, changes in designs can be made when necessary. However, sometimes these methods can be misleading in designs. A product that is visually appealing in the model may not give the same result in real life. This is mainly associated with poor design awareness and the resulting inadequate use of technological means. In the initial stage, design awareness can be improved by touching and feeling after which, it could be developed with auxiliary tools. This is why it seems more feasible to practice traditional methods in the first years of architectural design education. Computer technologies could be more beneficial while still using some conventional methods in design.

Many of today's architectural designs are realized with virtual reality and parametric design methods due to the many advantages it provides. It is observed that its works related to this continue rapidly. In practice, it is very important to use tools that provide solutions with the least time, the most

economical way and the least error. For this reason, the use of technology in architectural designs becomes mandatory. The advancement of technology, which is constantly renewed and developed according to the needs, simultaneously affects the architectural design methods. These advances in architectural designs should be given to students who will become architects at the education stage.

The access to the endless opportunities offered by computer technology has affected all sectors including architecture. Architecture students should also be educated outside school settings. Students must follow global developments to provide critical and inquisitive thinking. This necessitates changes in the existing education systems. Traditional methods should be given at the beginning of architectural education. immediately afterwards, the most preferred methods in designs, where technology can be used, should be included in the training. Students should be introduced to virtual reality and parametric design methods during the architectural design education process. Designers design something that is known only vaguely. Designing the unknown based on predictions is only possible by questioning knowledge. Instead of being confined to current knowledge, transforming knowledge in line with the predictions will provide to a more accurate results in the making of an unknown design.

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